

Space Point Service

LarSoft Meeting

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Requirements and Features

- My goal was/is to produce a service or module which can do the following:
 - Reconstruct space points from hits in two or three views (not detector-specific).
 - Ability to produce diagnostic plots of reconstructed (x,y,z) vs. mc truth.
 - Ability to use mc truth information to guide reconstruction.
- Above requirements are currently implemented as a service.
 - Currently only works for vertical-wire geometry.

Use Cases

- Reconstruct space points from all hits.
- Reconstruct space points from all clustered hits.
- Reconstruct space points from hits in matched clusters or selected hits.
- Above cases can be done with or without using mc truth information to guide the reconstruction.

Identifying Space Points

- For any two views, require hits to be in-time (after correction).

- $|t_1 - t_2| \leq \Delta t_{\max}$.

- For three views, require wire separation to be small.

- $|\sin(\theta_v - \theta_w)u + \sin(\theta_w - \theta_u)v + \sin(\theta_u - \theta_v)w| \leq S_{\max}$.

Reconstructing Space Points

- x position reconstruction using weighted average corrected time.
- (y,z) position reconstruction using chisquare minimization (sum over views):

$$\chi^2 = \sum_i (u_i - x \cos \theta_i - y \sin \theta_i)^2$$

Config Parameters

```
microboone_spacepointservice:
{
  Debug: 1          # Enable debugging printout
  Hist: true       # Fill diagnostic histograms
  MCHist: true     # Fill reco vs. mc histograms.
  UseMC: true      # Use mc info to guide reconstruction.
  MClabel: daq     # Simhits label.
  MaxDT: 25.       # Maximum time difference.
  MaxS: 2.         # Maximum 3-view wire separation.
  TimeOffsetU: -90. # U time correction.
  TimeOffsetV: -81. # V time correction.
  TimeOffsetW: -72. # W time correction.
  MinViews: 3
  EnableU: true
  EnableV: true
  EnableW: true
}
```

Tuning Parameters

- Tune time offsets using data or mc to make average time difference of in-time peak zero.
- Tune overall time offset to make x -offset between reconstructed position and mc position (or external reference) zero.
 - Note that (y,z) position reconstruction does not have any tunable parameters.
- Tune selection cuts (max time difference, max wire separation).

Optimizations

- Loop over view with fewest hits first, most hits last.
- Hits are sorted by time. Calculate (t_{\min} , t_{\max}) for inner loops and only loop over those hits.
 - It may be more effective to sort hits for inner loops by wire number.

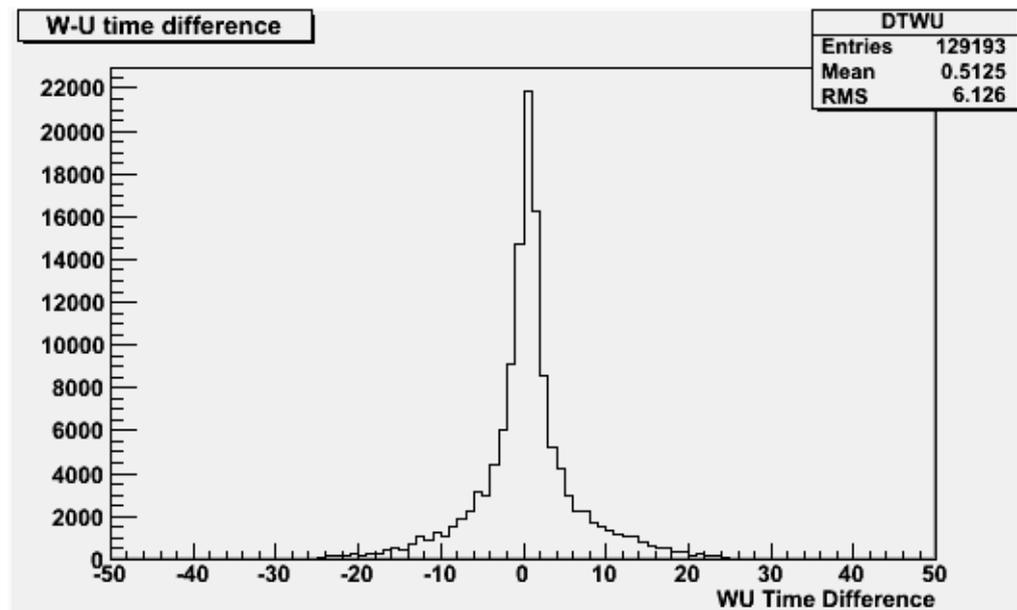
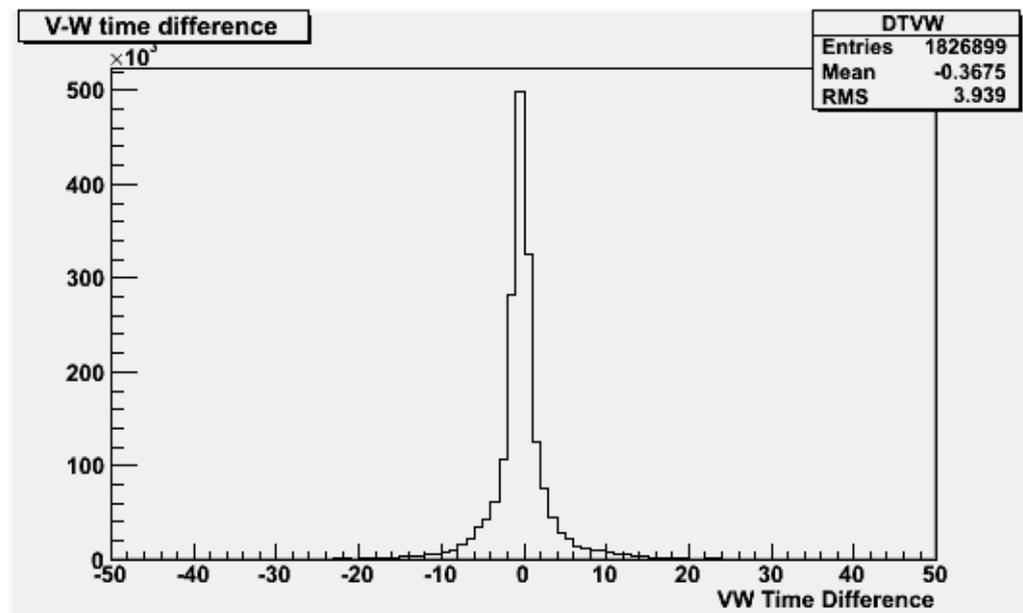
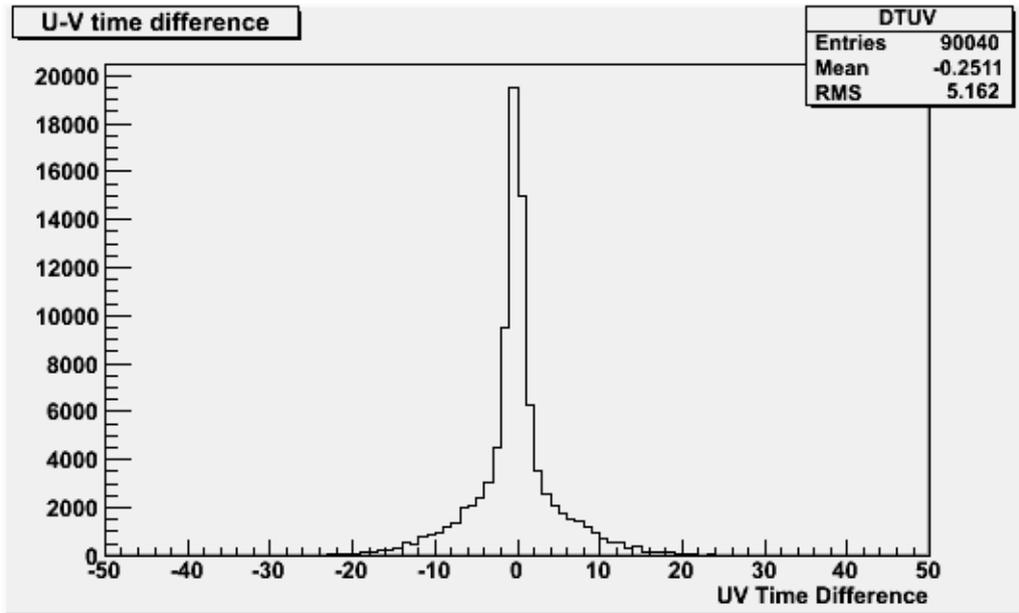
Public Interface

- Two main methods.

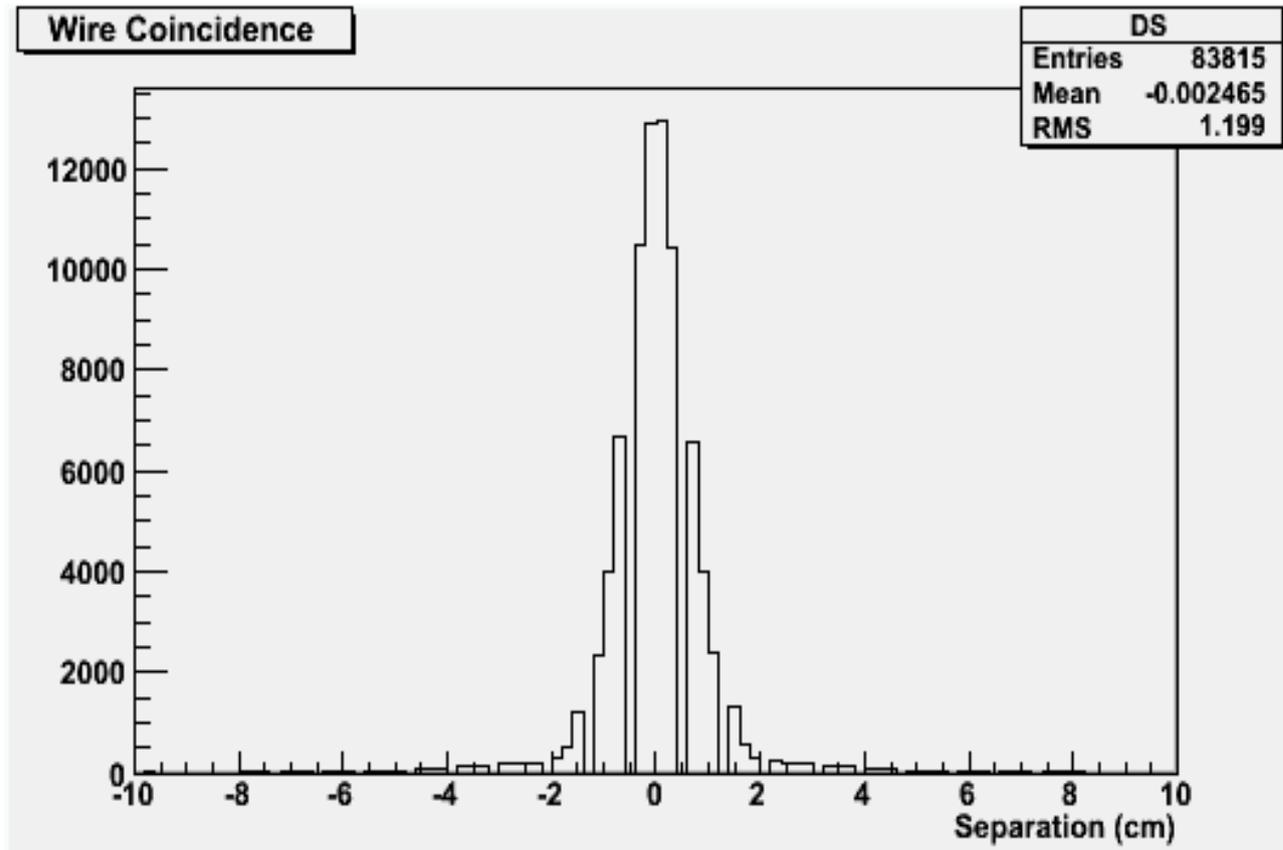
```
void makeSpacePoints(const art::Handle< std::vector<recob::Hit> >& hith,  
                    std::vector<recob::SpacePoint>& spts,  
                    const art::Event* pevt = 0) const;  
void makeSpacePoints(art::PtrVector<recob::Hit>& hits,  
                    std::vector<recob::SpacePoint>& spts,  
                    const art::Event* pevt) const;
```

- Use first method to reconstruct space points using all hits of a given type in an event.
- Use second method to reconstruct space points using selected hits.

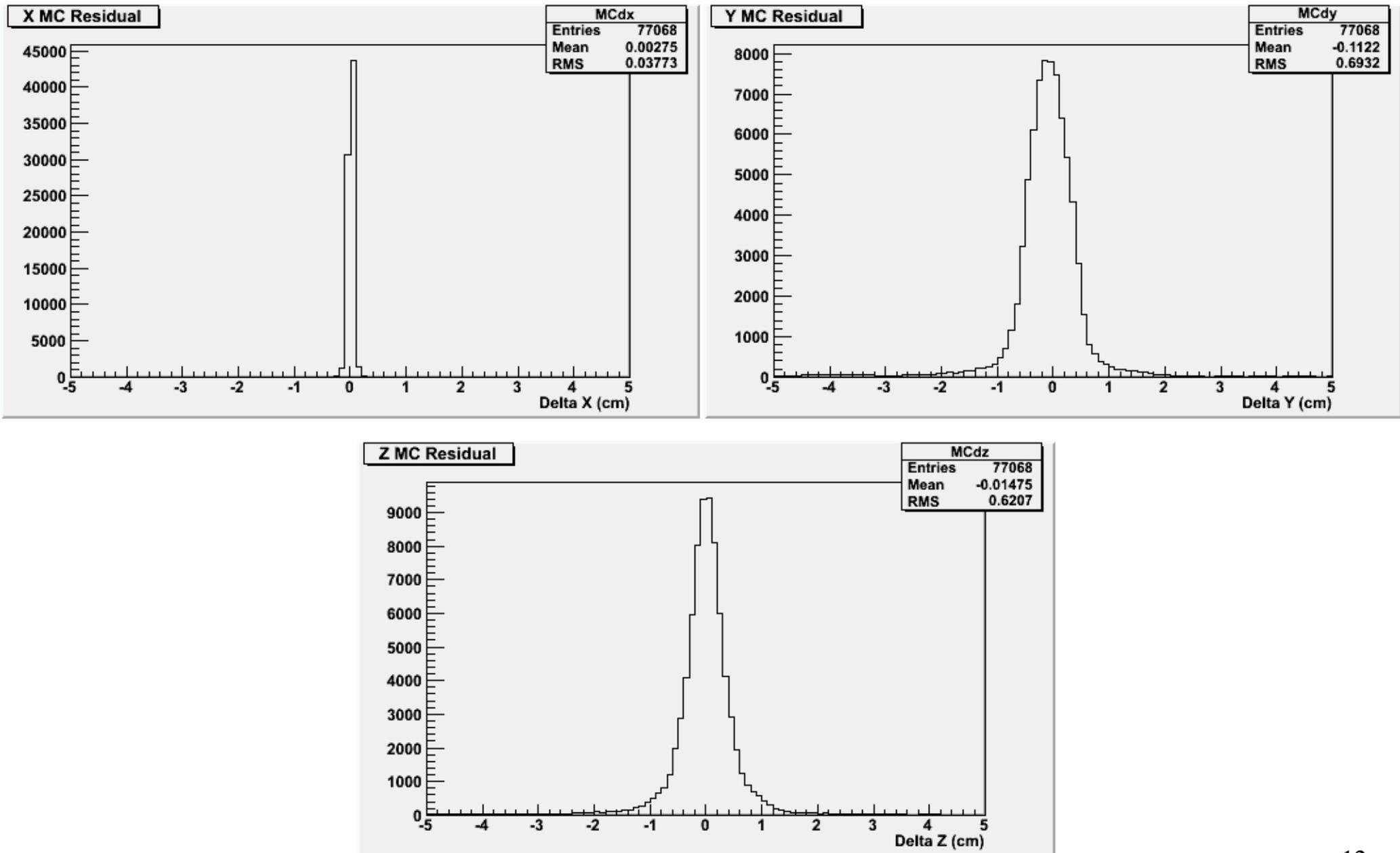
Corrected Time Differences (Microboone)



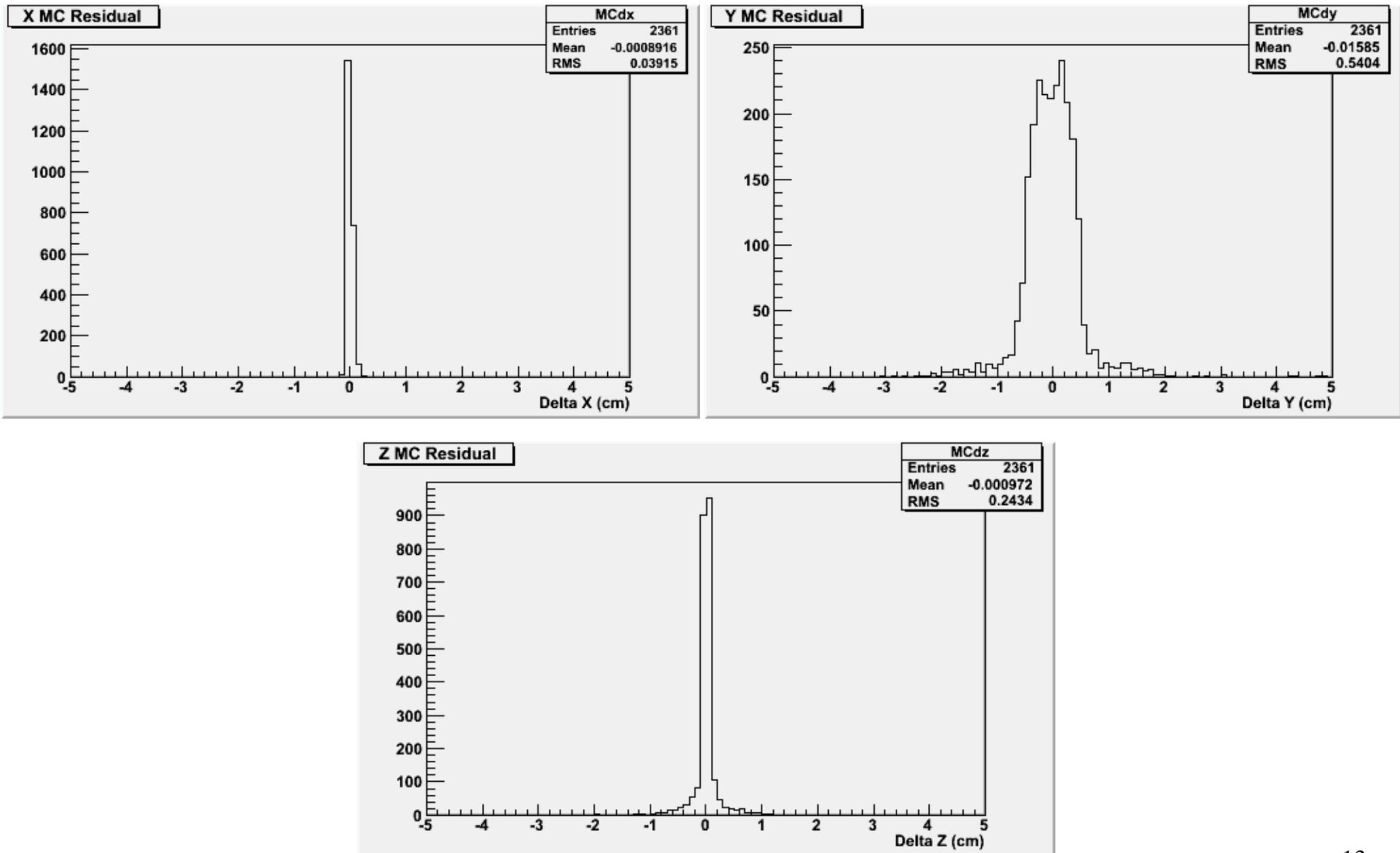
3-View Separation



Reco vs. MC Position (Microboone)



Reco vs. MC Position (Argoneut)



Tasks

- Got a large number of suggested changes (some quite technical) from Brian & Eric.
- Add a permanent analysis module. Move filling of histograms to analysis module.
- Is it possible to get time offsets without hand-tuning?
 - At a minimum need to make more information available via `DetectorProperties` or `LArProperties`.
 - FFT lineshape time offset?
 - Fix buggy geometry?